PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Internal Combustion Engines operating with Supercharging

I, WALTER SCHENKER, Swiss Citizen, of Winterthur, Switzerland, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to internal combustion engines operating with supercharging which is effected by a compressor driven by a turbine actuated by the exhaust gases from the engine. The invention has for its object to provide a method and apparatus for carrying such method into practice whereby the operation of the turbine and the delivery of supercharging air by the compressor can be maintained under varying operating conditions.

In the method according to this invention when there is a deficiency in the supply of exhaust gases flowing to the turbine or when the engine is not actually running, not only is the energy needed to drive the supercharging compressor produced as and when required by imparting heat to the gases flowing to the turbine or to air supplied if necessary when gases are not available from the engine, but this heating of the gases and of the separately supplied air if the latter is required is regulated automatically. Apparatus for carrying the improved method of operation into practice comprises in combination a supercharging compressor driven by a turbine actuated by exhaust gases from the engine, or when the engine is not running by air supplied thereto under pressure, means for imparting heat to the exhaust or other gases flowing to the turbine, and means for controlling the supply of such heat whereby energy needed to drive the supercharging compressor can be produced as and when required.

Heating of the gases may be effected either by indirect means, such as a coil over which the gases flow and through which a hot fluid is passed, or by direct means, for example by combustion of fuel in the gas stream. Regulation of the heat is determined in accordance with a working value either of the internal combustion engine such as the load on the engine, or of the turbine for example its speed, or in accordance with a value of a condition of the air delivered by the compressor. In effecting the object in view in this invention, it is possible to start the exhaust gas turbine when the internal combustion engine is not running and consequently when no exhaust gases are available. In this case an auxiliary motor drives an air compressor from which air flows directly to the turbine.

The present invention enables greater efficiency to be obtained as compared with internal combustion engines of the known type in which supercharging is effected by means of a turbine driven by the exhaust gases which have been heated as they flow from the engine to the turbine. In such known engines when the supply of exhaust gases is not sufficient to enable full supercharging to be effected thereby, it is necessary to provide a compressor driven by a separate source of power which supplied compressed air either in parallel or in series with the air supply from the turbine driven compressor.

The invention is also to be differentiated from a known arrangement in which the supercharging pressure is regulated by delivering heated air into the exhaust gases passing from the engine to the turbine the supply of this air being adjusted in dependence on the operation of the engine.

The accompanying drawing shows diagrammatically and by way of example how the present improved method of operating an internal combustion reciprocating engine may be carried out in practice.

The internal combustion reciprocating engine 1, the piston 2 of which drives the crankshaft 3, is connected by the exhaust pipe 5 which runs from the exhaust ports 4 with the turbine 8, which comprises a runner 6 and guide wheels 7, the shaft 9 of this turbine driving the compressor 10. The compressor 10, which comprises two runners 11 with guide wheel 12 between them, delivers air to the internal combustion engine through the pipe 13, check

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valves 14 and admission ports 15. The fuel is supplied to the engine 1 through the fuel valve 16.

If the heating of the air is effected by indirect means, there may be used a pipe coil 17, shown in dotted lines, through which a medium flows which is heated to a temperature above the exhaust gas temperature, the flow of this medium being regulated in amount by adjustment of the valve 18.

If the air is directly heated as by combustion of fuel, this fuel is injected into the passage 5 through a nozzle 19 by means of a pump 21 driven by an electromotor 20, the quantity of the fuel being determined by the regulating valve 22. A chamber 24 is provided for the fuel combustion in the passage 5 in which chamber an electric ignition device 25 is arranged to ignite the fuel in case there are not sufficient exhaust gases or the temperature of these exhaust gases is too low. The regulating valve 18 or 22 is adjusted by the governor 26 in accordance with the number of revolutions of the turbine shaft 9 which in turn is dependent on the number of revolutions of the exhaust gas turbine 8.

The operation of the plant described is as follows:—

If the internal combustion piston engine has been running for instance under full load ad its load is reduced, the supply of exhaust gases to the turbine 8 decreases. The temperature of the exhaust gases also decreases and the volume of these gases becomes less and the efficiency of the turbine 8 decreases. The number of revolutions of the turbine 8 and of the compressor 10 decreases, as the tendency exists to adapt to the reduced output of the turbine the less high demand for power by the compressor at a smaller number of revolutions. Owing to the reduction of the number of revolutions the governor 26 opens the regulating valve 22 and consequently the fuel admission through the nozzle 19, it being assumed that the pump 21 has been already started. If the exhaust gases are hot enough, the fuel ignites at once, but if the temperature of the exhaust gases is too low the ignition device 25 has to be switched on.

The additional heating by combustion of injected fuel is rendered possible because only part of the air delivered by the compressor 10 is used for the combustion in the engine 1 and air in excess is still present in the exhaust gases coming from the outlet ports 4. The air supplied to the turbine 8 prior to its entering the turbine is thus heated and to a variable extent so that in spite of the insufficient supply of exhaust gases from the engine, or even if this supply fails, the energy lacking for driving the compressor 10 can be produced according as required. By the additional combustion the volume of the air and of the exhaust gases and consequently the useful energy contained in them are increased. The regulation is preferably such that the volume increase is sufficient at least for the production of an output of the exhaust gas turbine which corresponds to the demand for power for the compressor 10, if in this compressor there has to be carried out the total work of compressing the supply of air corresponding to the loading of the internal combustion engine 1.

As is known, the exhaust gas turbine supercharging is started and maintained merely with the aid of the internal combustion engine at a low supercharging pressure amounting to only a few tenths atmosphere pressure. At high supercharging pressures, for instance, of several atmospheres, it may be advantageous to start the turbine 8 and the compressor 10 before the internal combustion engine 1 is started. Then for starting the compressor 10 an electromotor 27 is connected for instance to the main supply of current and a clutch 28 is engaged. When the valve 30 is opened the air supplied by the compressor 10 flows directly to the turbine 8 through the pipe 29 avoiding the internal combustion engine 1. In two-stroke cycle and also in four-stroke cycle internal combustion reciprocating engines such a by-pass conduit may be necessary if when standing there is no provision or insufficient provision for the passage of air through the admission and discharge elements of such engines.

After the motor 27 has brought the compressor 10 and the turbine 8 to their starting speed, the heating by means of the heating coil 17 or by means of the combustion of fuel supplied through the nozzle 19 is started, the fuel being then ignited by the ignition device 25. As soon as the number of revolutions for starting has been attained, the clutch 28 can be disengaged, the motor 27 is stopped, and the driving of the turbine 8 is effected by means of the heated air until for instance the discharge from the compressor 10 corresponds to the demand for air for the internal combustion engine 1 when running idle.

If the output of the exhaust gas turbine 8 has to be increased to an especially high degree or if the operation of the compressor 10 at the lightest load on the internal combustion engine 1 has to be ensured, additional air under pressure can be supplied for instance by means of a

compressor 31, indicated in dotted lines, and driven from the internal combustion engine 1, through the pipe 32 into the passage 5, or through the pipe 35 into the passage 13. This additional supply of air under pressure enables the indirect heating or the fuel combustion to be increased and thereby increase the output of the turbine beyond that due to the normal quantity of the exhaust gases from the internal combustion engine, without exceeding the maximum temperature of the exhaust gases permissible with respect to the blades of the turbine. If a blower 34 driven by an electromotor 33 is provided instead of the compressor 31, this blower may also be used for starting the turbine 8 when exhaust gases from the internal combustion engine are not available. In this case the motor 27 is not necessary.

Instead of using the governor 26 the regulation of the heating may be effected in accordance with the number of revolutions of the internal combustion engine, or the pressure or temperature in the passage 5 or in the chamber 24, or the temperature, pressure or quantity of air in the passage 13. The quantity of air flowing through the pipe or passage 13 may be measured in a known manner by means of a Venturi tube or orifice through which the air has to flow, the pressure difference on each side of the Venturi or orifice being a measure of the quantity flowing and differing from the absolute pressure in the passage. By enlarging the cross-section of the passage in the chamber 24 in relation to the cross-section of the pipe 5 the advantage is attained that, owing to the decreased speed of the flow of air and exhaust gases on entering the chamber 24, the passing of unburnt fuel into the turbine 8 is prevented and also loss of fuel is obviated.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A method of operating an internal combustion engine having a supercharging compressor driven by an exhaust gas turbine in which when there is a deficiency in the supply of exhaust gases flowing to the turbine or when the engine is not actually running, not only is the energy needed to drive the supercharging compressor produced as and when required by imparting heat to the gases flowing to the turbine, or to air supplied if necessary when gases are not available from the engine, but this heating of the gases, and of the separately supplied air if the latter is required, is regulated automatically.

2. A method of operating an internal combustion engine having a supercharging compressor driven by an exhaust gas turbine as claimed in Claim 1, in which the heating of the gases or the air is effected either by the combustion of fuel which takes place in the passage through which these gases flow to the turbine or by a heating coil disposed in that passage.

3. A method of operating an internal combustion engine having a supercharging compressor driven by an exhaust gas turbine as claimed in Claim 1, in which the heat imparted to the gases or the air flowing to the turbine is regulated in accordance with a working value of the engine, or of the turbine, or a value of a condition of the air supplied by the compressor.

4. In an internal combustion engine operating with supercharging, the combination with a supercharging blower driven by a turbine actuated by exhaust gases from the engine or when the engine is not running by air supplied thereto under pressure, of means for imparting heat to the exhaust gases or air flowing to the turbine, and means for controlling automatically the supply of such heat whereby energy needed to drive the supercharging compressor can be produced as and when required.

5. An internal combustion engine operating with supercharging as claimed in Claim 4, in which the supply of heat to the gases or air flowing to the turbine is controlled by a governor mounted on or driven by the turbine shaft or the crankshaft of the engine.

6. Apparatus for carrying out the herein described method of operating an internal combustion engine having a supercharging compressor driven by an exhaust gas turbine as described with reference to the accompanying diagrammatic drawing.

Dated this 21st day of December, 1939.
KILBURN & STRODE,
Agents for the Applicant.

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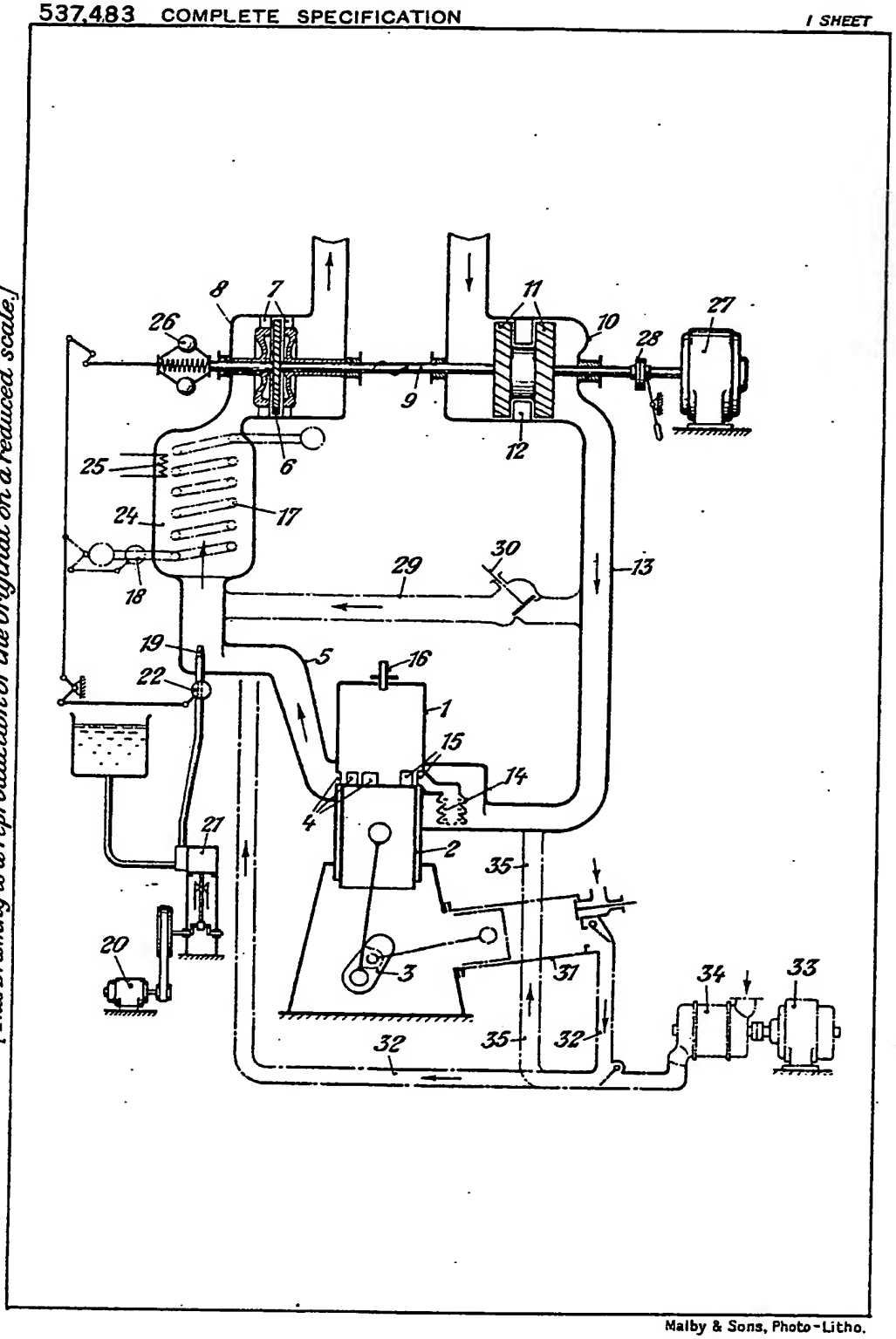
ERRATUM

SPECIFICATION No. 537,483.

In the heading on page 1, *for* " No. 32678/39 " *read* " No. 32678/39 "

THE PATENT OFFICE,
October 11*th*, 1941.

537,483 COMPLETE SPECIFICATION 1 SHEET



[This Drawing is a reproduction of the Original on a reduced scale.]

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